THE OSTEOLOGY OF THE *DIADECTIDAE* AND THEIR RELATIONS TO THE *CHELYDOSAURIA*

E. C. CASE
State Normal School, Milwaukee, Wis.

Our present knowledge of the family *Diadectidae* has been obtained almost entirely from the writings of Cope. His work was done upon fragmentary material from the Permian beds of Texas—including, however, a few fine skulls—and was largely of a systematic character. Scattered through his many papers on this family are many brief notices and descriptions of anatomical characters, but nowhere has he given even an approximately complete description of the osteology. A summary of these brief notices would have no value beyond the historical. Suffice it to say that with his wonderful acumen he foresaw in his fragmentary material much that the more perfect material here described has made evident. For the bibliography and synonymy of the family the reader is referred to Hay's *Catalogue of the Fossil Vertebrata of North America* (Hay, 1902).

The material upon which the following description is based consists of several specimens collected by the author in the Permian beds of Texas, and now in the collection of the University of Chicago. The numbers given are the numbers of the University collection of fossil vertebrates.

The specimens consist of one nearly complete skeleton and several less perfect, as follows: (1) a skeleton lacking only the feet and free from distortion, No. 1075; (2) the anterior portion of a skull with the complete right half of the lower jaw and a portion of the left and a considerable portion of the vertebral column, No. 1076; (3) the sacrum and seven presacral vertebræ of a much larger specimen, No. 1077; (4) the major portion of a skull showing the palatal region nearly perfectly, No. 1078; (5) an imperfect skeleton showing the caudal region and some of the limb and foot bones, No. 62.

In 1896 Cope described (Cope, 1896) from the Permian of Texas two genera, which he called *Otocoelus* and *Conodectes*. These he placed in a new family of the *Cotylosauria*, the *Otocoelidae*, which he described as follows:

> Posterior border of the temporal roof excavated laterally by the meatus auditus externus. Teeth present in a single row, not transversely expanded. Ribs immediately overlaid by parallel transverse derm-ossifications which form a carapace.
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> In the presence of the meatus auditorius this family differs entirely from the other members of the *Cotylosauria*. In the latter the vestibular space is inclosed by the lateral part of the temporal roof, and has no distal inferior bounding wall. The meatus results in the *Otocoelidae*, not merely from the excavation of the roof, but also from the excavation of the posterior border of the suspensorium. In *Conodectes* this excavation is not great, but in *Otocoelus* it is very considerable, the proximal extremity of the suspensorium having the anterior position seen in the *Loricata* and the *Testudinata*. It resembles the quadrate of the latter order in the decurvature of the proximal extremity into a descending hook, which partially bounds the meatus posteriorly.
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> This meatal excavation constitutes an approximation in the *Cotylosauria* to other and later orders of the *Reptilia*, where it is nearly universal. It is interesting to observe that it precedes in time the division of the roof into longitudinal bars by perforation, in the series of which the *Otocoelidae* form a part. This fact renders it probable that it is from this family that the order of the *Testudinata* has descended. . . . . In this family the slight posterior concavity of the quadrate region of the *Diadectidae* is extended forward to a great distance, and the osseous tympanum is produced farther outwards.

Later, in 1898 (Cope, 1898), he erected this family into a distinct order, the *Chelydosauria*, defined as follows:

> These reptiles possessed a carapace of transverse osseous arches which extended across the back from side to side in close contact. The anterior part of the scapular arch below resembles the corresponding part of the plastron of a tortoise. The temporal roof is excavated posteriorly for the auricular meatus. The order is probably ancestral to the *Testudinata* and the *Pseudosuchia*.

In his synopsis of the orders of the *Reptilia* he describes the order as with the "scapular arch internal to the ribs; temporal region with complex roof and no longitudinal bars. A presternum; limbs ambulatory."

Cope regarded the *Otocoelidae* as the only family of the new order, but it will be seen from the following descriptions that the *Diadectidae* must be included therein. The order *Chelydosauria* is

clearly distinct from the *Cotylosauria*, the points of ordinal difference being the exposure of the quadrate to the lateral surface of the skull, the meatus auditus externus forming a third pair of openings in the skull roof, and the peculiarities of the palate cited below. The presence of a more or less well-developed carapace is perhaps definitive, but, as it occurs in many Permo-triassic reptiles, and even in *Amphibia*, *Dissorophus*, it is not fundamental. Cope included in the *Diadectidae* (Cope, 1896[1]) *Diadectes*, *Empedias*, *Chilonyx*, *Bolbodon*, and *Phanerosaurus*, which he defined as *Cotylosauria* "with hyposphen-hypantrum vertebral articulation, and teeth with robust, molariform crowns transverse to the jaws" (Cope, 1898).

Of these, *Chilonyx* and *Phanerosaurus* must be excluded from the *Chelydosauria*, as the quadrate is covered on the lateral surface by the squamosal and prosquamosal bones, and there is no external meatus perforating the skull wall; *Bolbodon* is a very uncertain form, the condition of the specimen rendering an accurate judgment impossible.

DESCRIPTION OF SPECIMEN NO. 1075

The total length of the specimen as it lies is about 1.08^{m}. This is nearly the natural length, as only a few inches of the tail seem missing. The animal either died in the soft mud in which it is preserved, or was entombed therein immediately after death, as there is no trace of movement by currents or the attacks of predatory animals. The fine mud penetrated all parts of the skeleton, preserving the bones in their natural position almost perfectly. Unfortunately, the distal portion of all the limbs have been lost, so that only the proximal halves of the radius and ulna, tibia, and fibula have been preserved. As shown in the photograph (Fig. 1), the head is somewhat erect. This is not entirely the accident of fossilization, for, as pointed out by Boulenger, the Cotylosaurians had no neck to speak of, and the position of the head is partly the result of its close attachment to the body. The thoracic and pelvic girdles, because of their peculiar solidity, have been preserved undisturbed, with the exception that the scapula-coracoids of the two sides have been pressed together about 1^{cm}, giving a false appearance of overlapping. The vertebræ are in the normal position above the

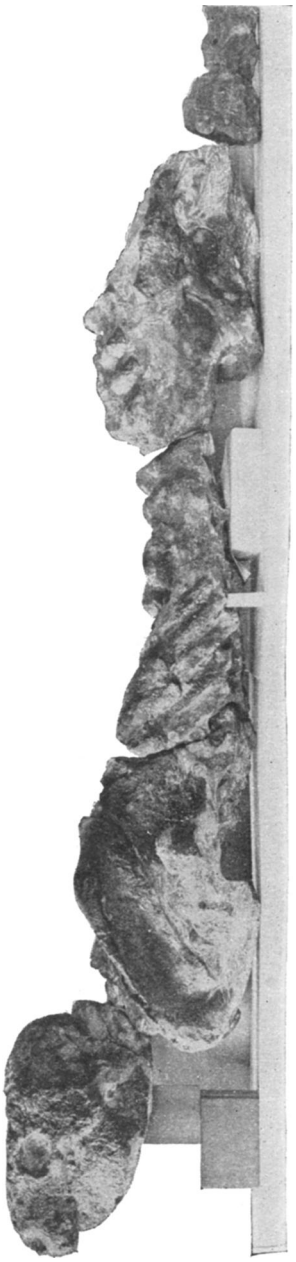

FIG. 1.—Photographs of the skeleton of specimen No. 1075.

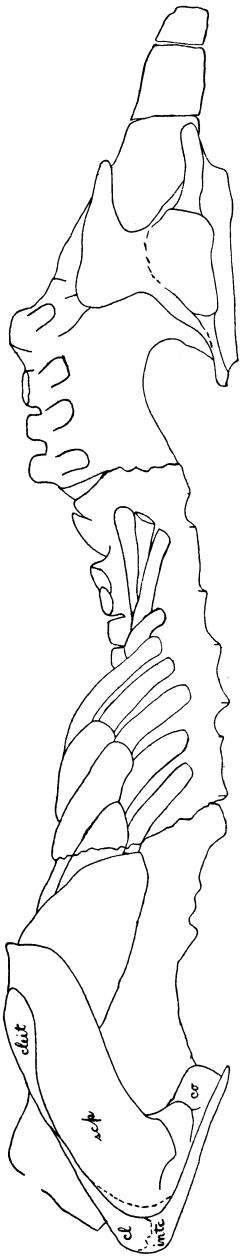

FIG. 2.—Outline of the skeleton of specimen No. 1075. *cl* = clavicle, *clst* = cleithrum, *co* = coracoid, *intc* = interclavicle, *scp* = scapula. One-fifth natural size.

girdles, but in the post-dorsal and lumbar regions the column has sagged down of its own weight, causing a break and slight displacement, vertically, of the column. One peculiar effect of the sagging down of the vertebral column is that the ribs of the thoracic region have been bent upward and backward, reversing the natural curvature so that the plates covering them seem to be on the ventral surface. The upper edges of these ribs and the dorsal edge of the scapula stand well above the tops of the neural spines. The dermal plates, which are arranged shingle-wise, were evidently firmly attached together.

The humeri and femora of both sides are in position. The humeri are extended straight backward and the femora straight forward. This position, in harmony with the undisturbed condition of the rest of the skeleton, is important as indicating the natural position of the limbs and the prone position of the animal as it crawled upon its belly.

As described above, the skull has the lower jaws so fixed that it is impossible to clear the palate completely; but as it is entirely free from any distortion, the external form is perfectly shown. The surface of the skull, as in all of the *Diadectidae*, is very rugose, and the bones are closely anchylosed together, so that it is almost impossible to trace the sutures between the bones, such sutures as are given having been largely made out from the inferior surface of the skull in the less perfect specimens.

The skull is wide behind and narrows rapidly in the facial region, making the nose relatively thin, in this respect resembling the *Pariotichidae*. The skull proper is quite depressed, but seems much higher with the lower jaws in position, because of their great vertical extent. The upper surface of the skull is flat and of an elongate heart-shape. The parietal foramen lies near the posterior edge, and is not of such great size on the surface as to deserve the adjective "enormous" applied to it by Cope; but the edges of the foramen are beveled on the lower surface, so that the inner opening is two or three times the size of the outer. This is well shown in specimen No. 1078. There is no indication of grooves for the sensory organs.

Viewed from the side, the skull shows three openings; the exter-

nal meatus, the orbits, and the nares. The quadrate region with its opening is similar in all important particulars to the same region in specimen No. 1078. The quadrate bone is a little longer, but, as it has been impossible to free the region from all matrix, minor details are uncertain. The orbits are oval, longer than high, and look directly outward. The lower edge projects rather more than the upper, and can be seen if the skull is viewed directly from above. The antero-posterior diameter of the orbit is 0.045^{m}; the vertical diameter, 0.032^{m}. The nares are nearly circular and located at the extremity of the skull. They are placed obliquely, so that they look outward and forward. The posterior and lower walls are continued funnel-wise, the opening being in the upper anterior corner of the nostril.

The quadrate region has the greatest vertical extent of any portion of the skull, making the postorbital edge of the skull, jugal, and quadrato-jugal descend abruptly as a flange, covering the posterior portion of the jaw. The whole length of the lower edge of the skull is sharply concave, reaching its greatest height just anterior to the orbit and then descending slightly to the anterior end. The anterior end of the nose overhangs the lower jaws considerably.

Viewed from the front or rear, it is seen that the skull is much narrower than the jaws; the sides of the postorbital portion slant outward as they descend, so that the wall of the skull is oblique. The supraoccipital region is depressed between two projections of the posterior angles of the skull formed by the squamosal, or possibly even by an epiotic, though this last-mentioned bone cannot be made out. Its possible presence is inferred as possible from the condition of the *Pariotichidae*, where Cope reports its presence.

There are two small openings, the post-temporal foramina, on the posterior face of the skull near the outer edge. These open directly upon the petrosal and the upper face of the pterygoid, so that their enlargement would produce exactly the condition of the *Chelonidae* among the turtles.

The total length of the skull from the anterior end of the nose to the posterior end of the slightly projecting lower jaws is nearly 0.2^{m}. The height across the skull and lower jaws is 0.125^{m} opposite the parietal foramen.

FIG. 3*a*

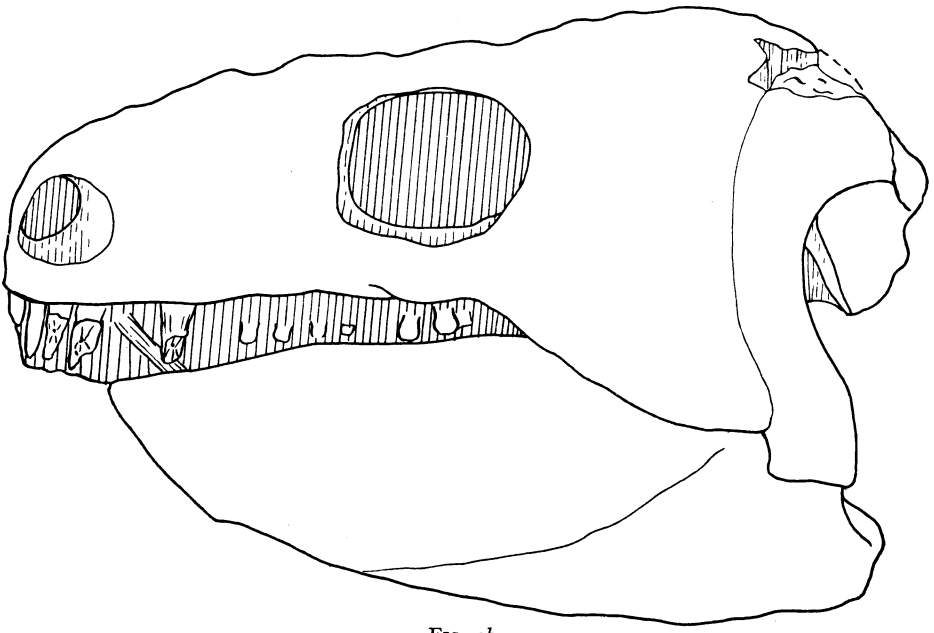

FIG. 3*b*

FIG. 3.—FIG. 3*a*, photograh of the skull of No. 1075; FIG. 3*b*, outline of the same skull.

In specimen No. 1078, from which the description of the palate is taken (with the exception of the vomer, which is taken from No. 1076), the skull is slightly crushed, the palate lying a little to the left of the normal position; but this has been so slight that the displacement does not amount to more than a centimeter, and the bones of the lower surface retain their connection with each other and the bones of the roof. The bones have been readily freed from a not very adherent matrix, so that the form and condition are beyond question (see photograph, Fig. 4), but the sutures

FIG. 4.—Photograph of the palate of specimen No. 1078.

are traced with difficulty. In specimen No. 1076 the skull was crushed badly, and the whole posterior portion is missing, but the lower jaws fortunately did not share in the crushing, and so show the form perfectly.[1]

[1] The matrix of specimen No. 1076 was a very hard calcareous material, which was so closely adherent to the bone that there was no line of parting where alteration due to weathering of the specimen usually marks the limits of bone and matrix. This made it almost impossible to clean the specimen with the chisel, so that recourse was had to the aid of acid, which readily attacked the matrix and the bone. As fast as a portion of the bone was freed from the matrix, it was coated with paraffin of a low melting-point, about 55° C., and the place was heated with the thin point of a blow-pipe flame until the paraffin sank into the bone, after which the attack with acid was resumed. It was found that the thin flame of the blow-pipe readily controlled the location of the paraffin, and that the heating was necessary, as simply coating the

Following is a description of the bones of the skull in detail.

The basioccipital.—The basi-occipital carries a widely oval, depressed condyle with a concave articular face. Laterally it passes into the exoccipital without appreciable sutures. It is impossible to make out the foramina.

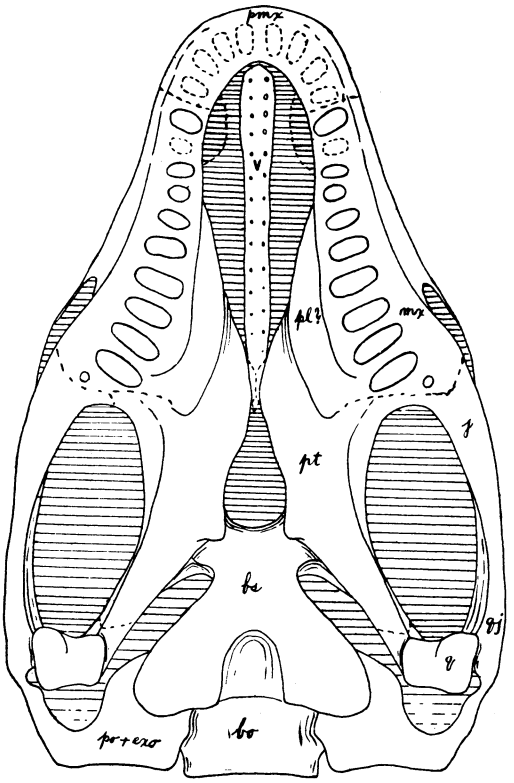

FIG. 5.—Restoration of the palatal surface of the skull from specimens Nos. 1076 and 1078.

The basisphenoid.—This bone has much the general form of the same bone in the *Pelycosauria* (Baur and Case, 1899; Case, 1905). It has the expanded posterior end where it unites with the basi-occipital, and a shallow concavity in the posterior portion of the mid-line of the lower face. The bone differs from the basisphenoid of the *Pelycosauria* in two particulars that are of great interest. (1) There is no anterior rostrum; the anterior end of the bone is rounded between the large basi-pterygoid processes, and there is no trace of any median process or of any rugosity. (2) The lower surface is not perforated by the twin foramina of the internal carotid arteries.

It is impossible to determine the limits of the bones of the brain

surface permitted the acid to work under the paraffin and damage the bone. When the specimen was cleaned from the matrix, the paraffin was readily removed by boiling the bones in water. The action of such solvents as xylol was not satisfactory in removing the paraffin.

case. Consequently no separate description can be given of the exoccipital, paroccipital, opisthotic, or petrosal. Cope reported that the opisthotic and paroccipital were separate in Empedias and Chilonyx (Cope, 1896), but I can find no trace of a separation in the specimens here described.

The quadrate.—This bone both in form and relationships is best compared with those turtles which have the quadrate open posteriorly. The rugose bones of the skull roof terminate abruptly

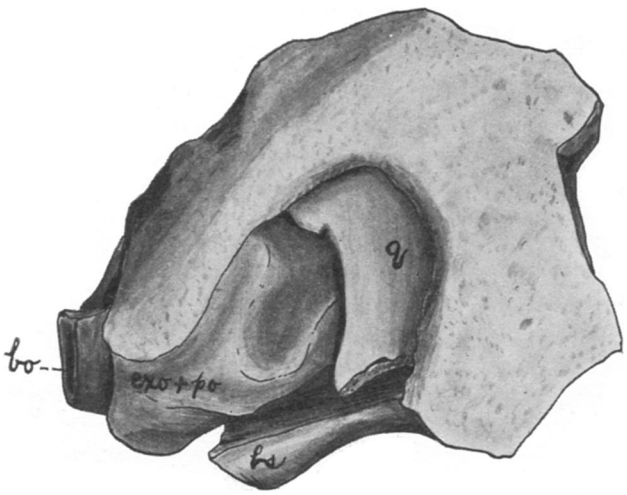

FIG. 6.—The quadrate region of specimen No. 1078. *q* = quadrate, *bs* = basisphenoid, *bo* = basioccipital, *exo* + *po* = exoccipital and paroccipital.

in the quadrate region, leaving an oval opening with its greatest axis vertical and open below. To the anterior and upper edge of this opening is attached the edge of the smooth quadrate, thus forming a conspicuous line of demarkation. The quadrate is approximately half funnel-shaped, pitching in on the upper, lower and anterior sides toward the center of the space. At this point the bone terminates by rounding in toward the center of the skull, leaving the posterior portion of the space open as the entrance of an opening to the interior of the skull. The upper part of the posterior edge of the quadrate is curved slightly downward, forming a hook. The lower portion of the quadrate is expanded into two articular faces which correspond to the articular faces of the

lower jaw. Viewed from below, the quadrate is seen to be a thin shell which is sharply convex posteriorly, the convexity forming the posterior edge described above. (The form is best appreciated by direct comparison with that of the turtles.) The outer side of this convex bone is attached to the roof bones, as described above. The inner side is attached to the pterygoid. There is a very considerable cavity between the upper portion of the quadrate and the roof of the skull anterior to it. There was no trace of a stapes preserved in the cavity of the skull posterior to the quadrate.

Cope has described the condition of the auditory region and apparatus as follows (Cope, 1886):

> The brain case in the *Diadectidae* differs from that of the *Clepsydropidae* much as that of the *Varanidae* differ from those of other *Lacertilia;* that is, it is continued between the orbits, so as to inclose the olfactory lobes of the brain within osseous walls. These walls are thin, especially at the interorbital region, and in the specimen the anterior extremity is so far imperfect as to leave the form of the anterior fundus in doubt. . . . .
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> The conformation of the cranial walls requires preliminary notice. In the first place, the vestibule of the ear can only have been separated from the brain by a membranous septum, as is the case in the *Protonopsis horrida* (Menopoma). In clearing out the matrix no trace of osseous lamina could be detected on either side, and the edges of the huge foramen thus produced are entire, and present no broken edges. Anterior to the vestibule, the proötic bone has a small extension, terminating in a vertical border. In front of this is the huge vertical foramen through which issues the trigeminus nerve, which is even larger than that found in the *Testudinata* and *Crocodilidae*. The anterior border of this foramen is formed by the probable alisphenoid, whose posterior edge is nearly parallel with the anterior border of the proötic, sloping forward as it descends. The basicranial axis is thin at their union on the middle line below, and, thickening forward, is excavated by a rather small conical fossa. Anterior to the fossa is a smaller impressed fossa, and on either side of it each lateral wall is excavated into a shallow fossa which descends toward it. The frontoparietal fontanelle is of extraordinary size. . . . .
>
> As already remarked, the internal wall of the vestibule is not bony, so that the cast of the brain cavity includes that of the vestibule also. On the external wall of the latter are the orifices of the semicircular canals. These are one double fossa at the superior anterior part of the wall, a second double one at the posterior superior part of the wall, and a single orifice at the inferior posterior part of the wall. The external part of the vestibule is produced upward and outward to the fenestra ovalis. The "double fossæ" above mentioned are the osseous

representatives of the membranous ampullæ at the junction of two pairs of semicircular canals.

On sawing open the periotic bones, which here form a continuous mass, the following is seen to be the direction of the semicircular canals: The superior canal is horizontal. The second canal from the posterior ampulla descends forward, and, after a course a little longer than that of the horizontal canal, turns posteriorly. The inferior canal from the anterior ampulla also descends, and, after a shorter course than the canal last mentioned, also turns backward and joins it, the two forming a single canal, which enters the vestibule by the single posterior foramen already described. The lumen of the longer perpendicular canal is much larger than that of the others. As its ampullar orifice is also the largest of all, I suppose this increased diameter to be partly normal; but it may be partly abnormal, as its walls are irregular and rough.

The fenestra ovalis is not preserved in this specimen, but can be seen in the crania of the species *Diadectus phaseolinus* and *Empedias molaris* above mentioned. The vestibule, or a diverticulum from it, is produced upward and backward, and terminates in a round os. This is clearly not a tympanic chamber, nor is it a rudimental cochlea. It does not appear to be homologous with the recessus labyrinthi, since that cavity is not perforated by the fenestra ovalis. It appears to be a promulgation outward of the vestibule and sacculus, which may be observed in a less degree in the genus *Edaphosaurus* (Cope), also from the Texas Permian formation. Here the adjacent bones are produced slightly outward, and the fenestra ovalis is closed by a large stapes similar in external form to the one I have described in the *Clepsydrops leptocephalus*. Its more intimate structure I have not yet examined.

The result of this examination into the structure of the auditory organs in the *Diadectidae* may be stated as follows: The semicircular canals have the structure common to all the Gnathostomatous *Chordata*. The internal wall of the vestibule remains unossified, as in many fishes and a few batrachians. There is no rudiment of the cochlea, but the vestibule is produced outward and upward to the fenestra ovalis, in a way unknown in any other family of the vertebrates.

The pterygoids.—These bones have the usual relations in the posterior part, but the anterior end is very different in its form and relations from that ordinarily found in the primitive reptiles. Near the middle point the pterygoids unite with the strong basi-pterygoid processes of the basisphenoid. There are strong anterior and posterior processes, but the external process which forms a buttress for the lower jaw, and is such a conspicuous feature of the skull of the *Pelycosauria* and the *Pariotichidae*, is totally absent. As this external process forms one of the chief points of attachment of the transverse bone, its absence in the skull is of considerable importance in

considering the affinities. The middle portion of the pterygoid opposite the processes of the basisphenoid is flat and even somewhat concave on the lower surface. The anterior processes extend forward and outward as flat plates to articulate with the jugal and the maxillary. The processes of the two sides diverge rapidly, so that, if they met in the middle line at all, it was only for a very short distance. The outer portion of the anterior end unites directly with the maxillary on the level of the under surface of the skull, but the inner edge rises in the skull, and its anterior part lies on the upper surface of the strong alveolar shelf or buttress of the maxillary (see description of maxillary below.) Between the anterior end of this portion of the pterygoid and the maxillary there is, seemingly, a small bone separated from the two by indistinct sutures. This I take to be the greatly degenerated transverse. The suture between it and the maxillary is marked by a large foramen.

The posterior portion of the pterygoid is vertical and joins the quadrate in the usual manner. There are no traces of teeth on the pterygoid.

The palatines.—These are very degenerate. The portion described by Cope as the palatines is evidently the anterior part of the pterygoids and the palatines he described as "maxillary ridges." They appear as ridges which originate near the middle of the maxillary bones and curve backward with them, growing gradually wider as they recede, till they terminate sharply near the posterior end of the maxillaries. At the same time the ridge curves downward and away from the maxillaries as a thin process which terminates in a sharp, rather rugose edge, much like the edge of the maxillary of a turtle after the horny sheath has been removed. This ridge is separated from the maxillary by an indistinct suture, so that it is evidently the palatine; but it occupies a most anomalous position in that it does not meet its fellow of the opposite side in the middle line, and is not articulated with the pterygoid except at the posterior end; neither does it touch the vomer. Cope mentioned teeth on what he regarded as the palatines, but I can find teeth on neither palatine nor pterygoid in two well-prepared specimens.

The transverse.—This has been described above with the pterygoid.

The vomer.—This is a single bone of considerable vertical extent which is attached anteriorly to the inner side of the premaxillaries, and posteriorly either ended freely or was touched by the anterior median portion of the pterygoids which met, or nearly met, in the middle line. Its lower surface is marked by a double ridge of sparsely set, small, conical teeth. It is impossible to trace the attachment of the upper edge of the vomer. Anterior to the parietal foramen there are, in the two skulls, the remnants of a descending median plate, but in neither can this be traced into contact with the vomer. It seems probable either that the vomer was attached to this plate by a bony connection which has been destroyed, or that there was a cartilaginous attachment between them. There is no trace of any prevomers. It is possible that in this weak palate we have the condition premised by those (Bland-Sutton, 1884; Broom, 1902) who have contended that the true vomer is the parasphenoid developed into secondary importance to supply a weakened palate.

The premaxillaries.—It is impossible in the specimens to make out the limits of these bones. Cope describes them as having short and strong spines, which ascend in the median line as far as the posterior edge of the external nares. In none is the number of teeth certain, but it does not exceed four or five. They are chisel-shaped incisors, evidently adapted to the cutting of pretty solid food.

The maxillaries.—The vertical portion of the maxillaries is very thin, but the alveolar surface is disproportionately widened to accommodate the alveoli for the great teeth. This alveolar edge, while quite wide, is not of great vertical thickness, and stands out abruptly from the side wall of the skull (formed by the vertical portion of the maxillary), as a sort of shelf upon the upper surface of which terminates the anterior end of the pterygoids and the transverse, as described above. There are eleven teeth in the portion which I take to be the maxillary. The posterior one is very small and peg-like, but the next to the last is nearly, if not quite, the largest of the series. The surfaces of the teeth are worn on the inner edge only, as described by Cope.

The palate in general.—It will be seen from the above that the palate is very aberrant and in no wise resembles the palate of the *Cotylosauria.* The bones are so closely united that it is difficult

to make out the sutures distinctly in all cases. Among the peculiarities of the palate are the following: There are no buttresses for the lower jaw on the outer portion of the pterygoids. The pterygoids end anteriorly on the upper surface of the maxillary, with a very degenerate transverse separating them only partly. The pterygoids touch the vomer only at the extreme posterior end, if at all. Because the palatines do not extend inward to meet in the middle line, there is a great median vacuity which is divided by the vomer. Into this vacuity the anterior nares open directly (Figs. 4 and 5).

The lower surface of the skull roof is marked by two descending processes which originate just posterior to the pineal foramen and extend forward well anterior to it. The lower ends of the processes are not preserved, but they are in the position of the descending plates of the parietal bones found in the turtles. Cope describes them as alisphenoids and mentions their extending forward to carry the brain case between the orbits. The upper ends of the plates are fused with the lower surface of the parietals, so that they cannot be reckoned as epi-pterygoids. Immediately in front of these two processes there is a wide process on the lower surface of the skull in the median line, so that it in some measure closes the anterior end of the space between the paired processes. This median process is continued forward and downward as a thin plate which lies immediately above the vomer, but in no specimen of the collection can be shown to connect with it. Possibly the two were united by cartilage. I take this median plate to be the forward and upward continuation of the basi-cranial axis, the ethmoid.

The lower jaw.—Except for the teeth, the lower jaw is peculiarly testudinate in appearance. The anterior portion has a relatively great height, due largely to the dentary; but there is a very inconspicuous coronoid process. The bones, like those of the upper portion of the skull, are so closely united that the sutures are almost unrecognizable.

The inner surface is marked by an enormous opening into the Meckelian groove. This opening is separated from one equally large on the superior surface of the posterior portion of the bone by a narrow bridge, presumably formed by the splenial. The cavity of the Meckelian groove is large, so that the jaw is practically a shell

with the upper portion thickened to receive the alveoli of the great teeth. The teeth are set in shallow alveoli, which do not reach to the outer side of the bone, but are separated from it by a deep groove,

FIG. 7.—Photograph of the inner surface of the right half of the lower jaw of specimen No. 1076.

the outer edge of which is formed by a narrow elevated edge of the dentary. In the anterior end of the jaw the teeth reach the outer

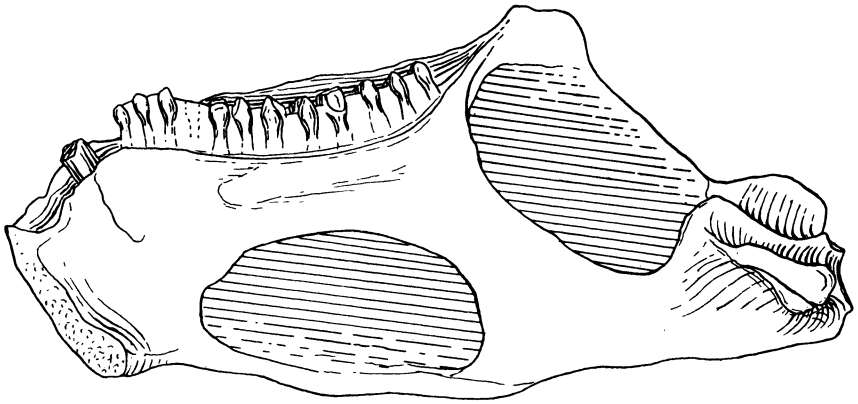

FIG. 8.—Outline of jaw shown in Fig. 7. One-third natural size.

surface. The anterior portion of the jaw descends slightly to the symphasis.

The posterior portion of the jaw descends rapidly from the coronoid; the articular surface is not above the middle half of the jaw. The articulation consists of two deep cotyli elongated in the anterior

direction and deeply concave from side to side. The shape is best shown in Figs. 8 and 9. The outer of the two cotyli is the larger, and is nearly twice as wide as the inner. It is impossible to distinguish the bones of this region as separate elements.

The outer face of the jaw is rugose, and near the anterior end of specimen No. 1076 it is marked by a depression evidently for the attachment of powerful muscles. This depression at first seems due to crushing, but there is no evidence of breaking, and the same thing occurs on both jaws. There is no such depression in the jaws of specimen No. 1075. The symphasis of the jaws was sutural, narrow, and nearly vertical.

There are eleven of the wide molariform teeth, and one empty alveolus in the posterior portion of the jaw. Anterior to these there is a single large incisor tooth, and the empty alveoli for four more, so that, if there was a small peg-like tooth at the posterior end corresponding to the small tooth at the end of the maxillary series, there were in all seventeen or eighteen teeth. The whole series of teeth is slightly concave from before backward and convex toward the middle line. The teeth are worn on the outer half only, to correspond with the wear of the inner side of the maxillary teeth. The posterior teeth are the wider, and after the posterior eight they rapidly narrow toward the front.

The shoulder girdle (the description of the shoulder and pelvic girdles is taken from specimen No. 1075).—The shoulder girdle consists of the interclavicle, clavicles, scapulæ, coracoids, precoracoids, and cleithra. The scapula, coracoids, and precoracoids are closely united. This, with the condition of the bones, makes it impossible to trace the exact form of the separate elements. The form of the three united bones is very similar to the scapula-coracoid figured by Broili as belonging to *Naosaurus* (Broili, 1904, Figs. 5, 5*a*, Plate XIII). This determination of the bones is erroneous, as it is very far from the condition of the *Pelycosauria* and closely approaches that of the *Diadectidae* here figured. The scapula is rather elongate and narrow vertically. Its posterior end terminates in a rather sharp point. The edge of the articular cotylus is very prominent, and the face looks backward rather than outward. In the *Pelycosauria* there is a foramen which penetrates the shaft of the scapula on the

outer side just posterior to the articular face, and passes forward and inward to open on the inner face of the bone in the bottom of a pit which also receives the opening of the coracoid foramen. In this specimen the foramen opens on the lower edge of the shaft and is almost within the articular space. Its position on the inner face cannot be given.

The line between the coracoid and precoracoid cannot be distinguished. The two bones extend forward and inward as flat plates which terminate in a straight anterior-posterior line medially. The two plates of the opposite side normally joined in a symphasis, but the two sides of the shoulder girdle have been pressed together, causing the two plates to overlap each other to the extent of about 1^{cm}. In addition to reaching inward to the middle line, the coracoid is extended so far backward that its posterior edge is nearly on a line with the posterior end of the interclavicle. There is a prominent articular face on the coracoid, opposed to the face on the scapula and arranged to permit the same sort of an oblique articulation with the head of the humerus as occurs in the *Pelycosauria*. Between the two articular faces originates a deep elongate pit which runs about 2^{cm} towards the precoracoid. It occupies much the same position as the cavity between the scapula and precoracoid figured in *Pareiasaurus* by Seeley and called by Furbringer the *Incisura (Fenestra?) coraco-scapularis*, but it does not open through the bone. I cannot imagine the meaning of this pit, unless it is a scar formed on the bottom of the humeral cotylus by the attachment of a very strong ligament, such as sometimes occurs in the acetabulum. The coracoid foramen cannot be made out. In the *Pelycosauria* it opens at the base of the scapular portion of the humeral face, but I cannot find it there in this specimen. However, it was undoubtedly present.

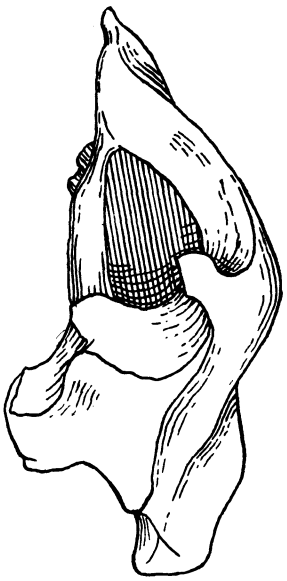

FIG. 9.—Rear view of jaw shown in Figs. 7 and 8. Natural size.

The inward and posterior extension of the coracoids and pre-

coracoids, and their union in the median line, made a strong ventral covering to the thoracic region not unlike that of *Procolophon.*

The cleithrum.—The posterior portion of the upper edge of the scapula is bordered by a short bone which is wider posteriorly and narrows to a point anteriorly. It is anchylosed to the scapula, but posteriorly the division is marked by a deep groove. The form is best seen in Fig. 2. Its anterior edge touches, but does not articulate with, the scapula. This bone is evidently the cleithrum. It has much the appearance of the same bone in *Pareiasaurus* and the scapula figured by Broili, mentioned above, and is in about the same stage of degeneration.

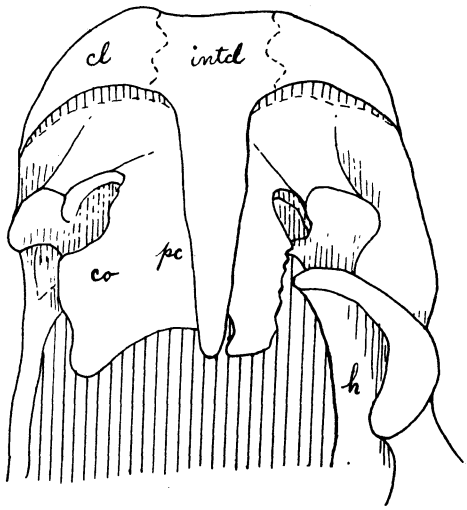

FIG. 10.—Ventral view of the shoulder girdle of No. 1075. *cl* = clavicle, *intcl* = interclavicle, *co* = coracoid, *pc* = precoracoid, *h* = humerus. One-half natural size.

The clavicles.—The clavicles do not meet in the middle line, but are separated by the interclavicle, with which they are closely articulated by strong sutural processes. Cope speaks of the symphasis of the clavicles behind the interclavicle, but this is an impossibility in the *Diadectidae,* as will be seen from the description and figures of the interclavicle. Viewed from above, the clavicles plus interclavicle have the form of a narrow horseshoe, the anterior end of the clavicles being wide and narrowing gradually to a point at about the posterior one-fourth of the scapula. The upper surface of the clavicles is quite flat. Viewed from the side, the anterior portion of the clavicles is broad, but rapidly narrows to an edge which disappears behind the cleithrum.

The interclavicle.—This bone is somewhat T-shaped. Its form is best seen in Fig. 10. The middle of the anterior end is slightly concave and rounded. Laterally the wing-like sides unite by strong

interlocking sutures with clavicles. The posterior process is continued backward, gradually narrowing to a point. Fig. 11 is a photograph of the interclavicle of a larger specimen (No. 1079), but shows the character of the surface and the connections with the clavicles.

FIG. 11.—Ventral surface of an interclavicle of a larger specimen than No. 1075—No. 1079.

The vertebræ. — Specimen No. 1077 consists of the two sacral vertebræ and seven presacrals. They are much larger than any of the specimens in which the skull is preserved. The whole series is characterized by the great width of the neural arch compared with the antero-posterior diameter. The neural spines are short and stout; the centrum is simple and deeply biconcave; there are no intercentra preserved. The anterior one of the seven presacrals is free from the others and very perfect, so that I have selected it as characteristic of a mid- or posterior dorsal. The anterior and posterior faces of the centrum are round and deeply concave, and it is perforated by the notochordal foramen. The lower edge of the centrum is slightly concave from before backward, and is without any median keel. The neural arch is anchylosed to the centrum, and there is no trace of the suture. As shown in Figs. 12–14, the anterior and posterior zygapophyses are far above the neural canal. The articular faces are almost flat, but are inclined slightly toward the median line, so that the anterior ones look inward as well as upward, and the posterior ones outward as well as downward. The posterior face is considerably higher than the anterior. Both faces are

marked by faint rugose ridges concentric around the inner end. Between the two faces and on a level with the posterior the transverse process for the rib originates and extends forward and downward until the lower end is just above the upper third of the anterior face of the centrum and directly below the anterior zygapophysis.

FIG. 12.—Anterior view of the seventh presacral vertebra of specimen No. 1077, showing hyposphene and pit above the neural canal.

On the anterior face of the vertebræ the inner ends of the articular faces of the zygapophyses are continued inward and downward as strong processes which bear on their inner ends the faces of the hyposphene inclined sharply inward and downward. These faces are shorter than the zygapophysial faces, but are fully as deep and as well developed. They form a striking feature of the vertebræ. Between the inner ends of the zygapophysial faces is a deep nearly round pit with a rugose bottom. It is directly above the neural canal, from which it is separated on the face of the vertebræ by a wide V-shaped partition. The posterior face of the inner ends of the zygapophyses are continued downward and inward as strong ridges which separate a deep triangular pit above, in the median line, from the hypantrum faces below. This triangular pit corresponds to the rounded pit on the anterior face, and the two evidently afforded attachment to a very stout ligament which bound adjacent vertebræ together. (Compare Cope's idea of the external form and habits given below.) The upper end of the neural spine is divided antero-posteriorly by a shallow, V-shaped channel. The anterior and posterior edges of the spine are drawn out into sharp edges, giving the whole a diamond-shaped section.

This vertebra is undistorted, so that the following measurements are characteristic:

Total height from the lower edge of the anterior face to the apex of the spine	0.143[m]
Width across the anterior zygapophyses	0.111
Width across the transverse processes	0.122
Antero-posterior diameter across the zygapophyses	0.066
Antero-posterior diameter of the centrum, approximate	0.036

The six presacral vertebræ following the one described above do not differ from it in many particulars. The centra become slightly

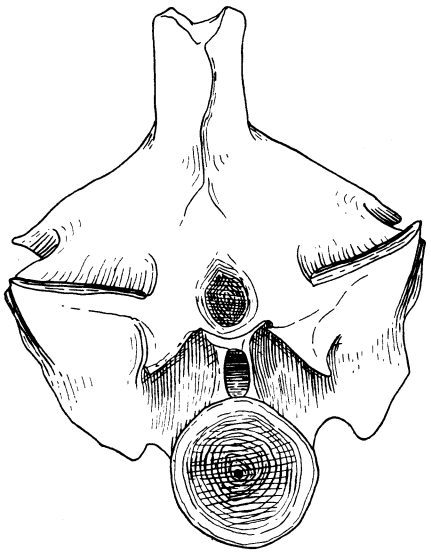

FIG. 13.—Outline of vertebræ shown in Fig. 12. One-half natural size.

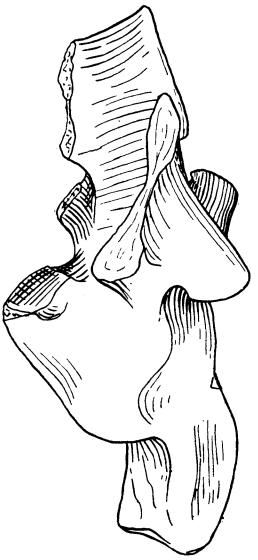

FIG. 14.—Lateral view of vertebra shown in Figs. 12 and 13. One-half natural size.

shorter in the posterior ones, the first presacral is the shortest, and the dorsal spines become irregularly larger and heavier. The main difference is in the size and position of the transverse processes. These become progressively shorter, and with less well-defined articular faces for the ribs, as they approach the sacrum. The shortening is accomplished at the upper end only. The lower edge of the process, except in the last two, remains opposite the upper fourth of the centrum, but the upper end gradually drops from a

point opposite a line connecting the zygapophysial faces to a point opposite the neural canal. The articular faces of all except the last two retain the same slant forward and downward as described

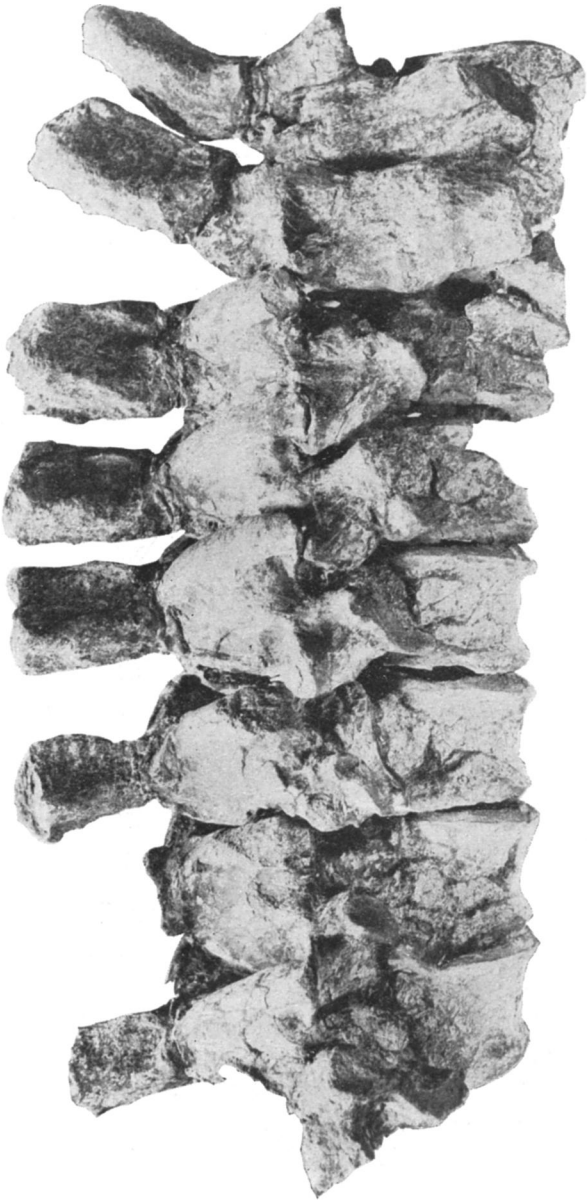

FIG. 15.—Photograph of the sacrum and six presacral vertebræ of specimen No. 1077.

in the seventh presacral. The last two vertebræ have the transverse processes much smaller than the preceding ones, and the upper end is much farther to the rear; the articular face is more nearly horizontal. The articular faces for the ribs are very poorly developed, in strong contrast with the condition of the more anterior vertebræ; these two may be recognized as lumbars.

The two sacrals present a strong contrast to the presacrals. They are closely anchylosed together, so that not only are the centra joined,

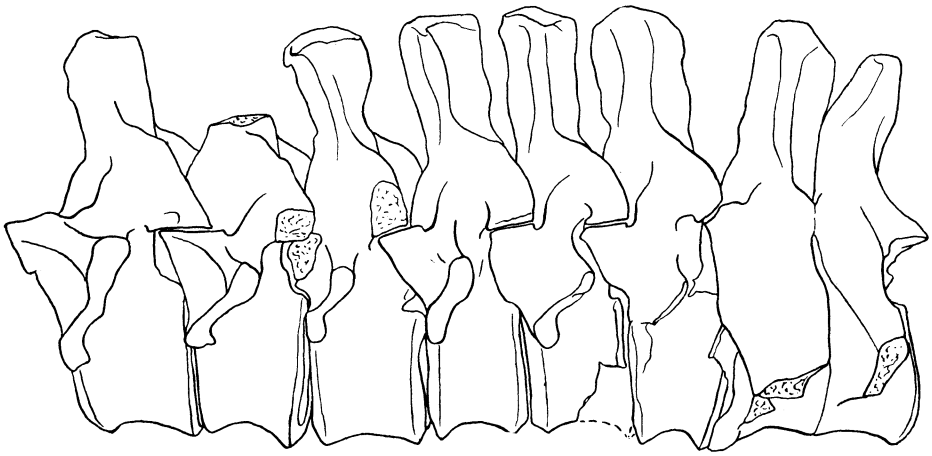

FIG. 16.—Outline of vertebræ shown in Fig. 15. One-half natural size.

but the zygapophysial articulations have disappeared and the processes pass into one another without suture. Both vertebræ present well-developed articular zygapophysial faces to the adjacent lumbar and caudal vertebræ. The transverse process of the first sacral is very wide, originating from the bases of the zygapophysial processes and maintaining a width equal to the anterior-posterior diameter of the centrum. The articular face for the rib is completely horizontal, but the rib is anchylosed to the process, so the face is traceable by a suture line only. The process and rib extend almost straight downward and articulate with the anterior end of the ilium (shown by specimen No. 1075). The transverse process of the second sacral is very much narrower and more rounded than the first, but extends downward, and is anchylosed with a sacral rib as in the first. The neural spine of the first sacral is larger than the

lumbar spines and is inclined sharply to the rear, leaving a considerable space between it and the last lumbar. The second sacral has a smaller and more slender spine than the first, but there is the same inclination to the rear. The neural arch, seen from above, is much narrower, and the sides are not rounded out into the almost hemispherical form characteristic of the presacrals. In fact, the sides of the neural arch are almost concave. The centra are abruptly longer than the last lumbar, and the bases of the centra are closely united. There is no intercentrum. Attached to the anterior edge of the first sacral is an intercentrum which underlies the space between the last lumbar and the first sacral. This is the only intercentrum preserved in the specimen. The total length of

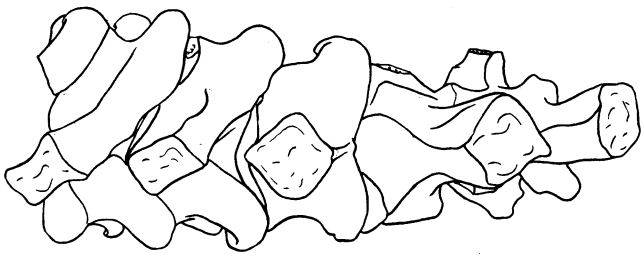

FIG. 17.—Superior view of the posterior five vertebræ shown in Fig. 16.

the sacrum and six presacrals is 0.33^{m}. The average height of the vertebræ is 0.165^{m}.

The vertebræ of specimen No. 1076 consists of five anterior dorsals in series, and, after a break, six more in series connected with the two sacrals, making thirteen in all. The vertebræ are smaller, but present no points of generic difference from specimen No. 1077 and are less well preserved. The five anterior vertebræ are all of the same type, and the description given of the vertebræ in No. 1077 is strictly applicable. In the middle of the series the heads of two or three ribs are preserved, and show that there was no division into a capitulum and tuberculum, nor any approach to such a division. There are no intercentra preserved. In the posterior series the transverse processes of the vertebræ show the same series of changes as described in No. 1077, and the sacrals confirm the observations made on that specimen.

In specimen No. 1075 the entire vertebral column is preserved, with the exception of a few terminal caudals. The vertebræ cannot be freed from the hard matrix sufficiently to warrant a complete description, but enough can be seen to show that they conform very closely to the descriptions given above of the other specimens, and that from anterior dorsals to lumbars there is very little change in form. The anterior cervicals are preserved, but the matrix at this point is exceptionally hard and is fissile, so that it has been impossible to make out this important region. A short cervical rib has been uncovered on one side. Although the anterior caudals of this specimen have not been made out, another specimen in the collection, No. 62, shows the caudal region. This shows that the tail was short, and that the posterior caudals were supplied with strong chevrons pointed sharply backward (Case, 1903; Fig. 10).

Intercentra are preserved in all parts of the column exposed, i. e., from the cervical to the lumbar. They are thin plates, only slightly curved, so that they extend only a short way up on the sides of the centra. They are broad antero-posteriorly. The intercentra simply underlay the point of contact of two centra and were not closely attached.

The ribs.—There were evidently ribs on all the vertebræ. The anterior cervicals are covered with matrix, but on one side a rib of about 2^{cm} has been exposed which was attached to either the second or the third cervical. On the third or fourth vertebra the ribs have reached a considerable length, and by the fourth or fifth the ribs have reached the greatest length of the body. As far back as the ninth vertebra the ribs have suffered the distortion described above, so that they are bent sharply backward and upward. In the posterior portion of the column the ribs curve sharply to the rear and gradually shorten, so that on the posterior dorsals and the lumbars they are quite short and slender. The dorsal plates overlie the ribs of the anterior vertebræ only. But four plates can be counted in series, but there were probably one or two anterior to them. In the description of specimen No. 62, mentioned above, the author described for the first time the occurrence of the plates in the *Diadectidae*. In that specimen they occurred as a fragment, but show the presence of at least five. In the anterior plates the ribs seem to be short and fused

to the under surface of the plates as in the turtles (this point is somewhat uncertain), but in the posterior plates the ribs are separate. The anterior plate is the broader and larger; the following ones diminish rapidly in size, and do not reach nearly to the end of the rib. It is evident that the plates did not cover the back, but lay on the sides of the body, with a wide interspace over the neural spines. In this as in other respects the carapace is much less perfect than in the *Otocoelidae*. Cope describes the shoulder girdle of the *Otocoelidae* as lying within the ribs. This does not occur in the *Diadectidae*. The plates lie between the scapula and the ribs. So peculiar is their position that at first glimpse they have a strong suggestion of beginning plastral elements.

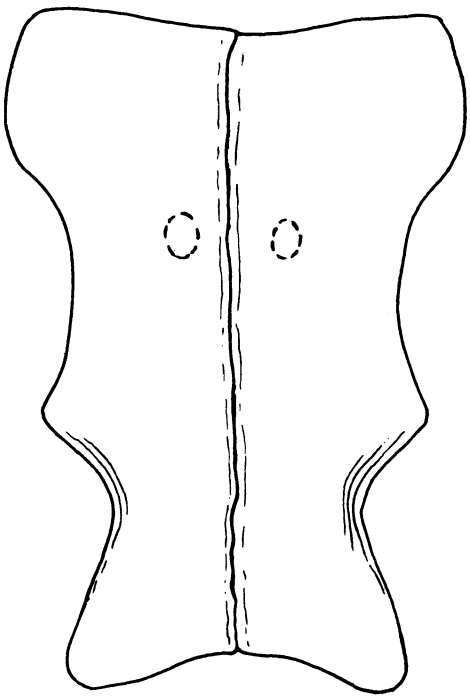

FIG. 18.—Outline of the lower surface of the pelvis of specimen No. 1075. One-half natural size.

The pelvis.—The pelvis shows the same adaptation to the depressed form of body as the shoulder girdle. The pubis and ischium are flat and plate-like, and the lower surface of the pelvis formed by the four bones is horizontal. There is no trace of the pubo-ischiadic suture, and the bones of the two sides meet in a straight symphysis, which is marked by an elevated ridge. The ilium stands vertically at a right angle to the other bones. (See Figs. 2 and 18.)

The ilium.—The crest of the ilium is nearly straight on the upper edge, the anterior end is rounded, and the posterior end is continued backward into a straight point. The lower portion forms the upper part of the acetabulum. The anterior edge of the lower parts slants forward and downward to join the pubis.

The pubis.—This is wide anteriorly and narrows slightly anterior to the acetabulum. The pubic foramen is near the middle of the bone. The anterior edge is nearly straight, but is slightly inclined backward toward the middle line, so the edge is somewhat notched.

The ischium.—This is narrower than the pubis and is sharply contracted posterior to the acetabulum, which has on this bone a

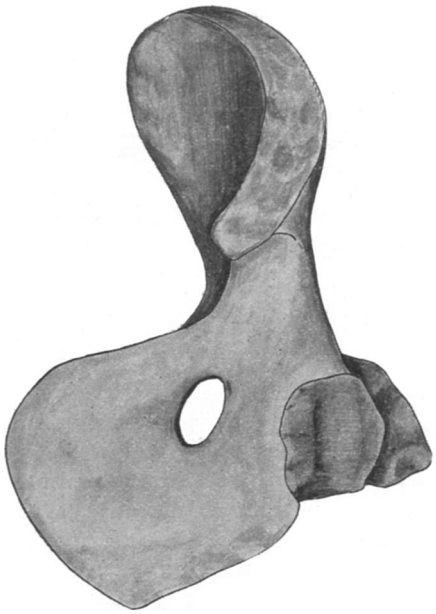

FIG. 19

FIG. 20

FIG. 19.—Anterior view of humerus of specimen No. 1075. One-half natural size.

FIG. 20.—Anterior, lower view of femur of specimen No. 1075. One-half natural size.

prominent rim. The posterior edge of the pelvis formed by the two ischia is even more deeply notched than the anterior.

The humerus.—This is a relatively short and wide bone, but of the same general type as occurs in all of the *Cotylosauria*. There is a very strong radial process reaching to near the middle of the shaft, and a large entepicondylar foramen near the middle of the lower end. The process for the head of the radius is broken away, but the entepicondylar process is exceptionally wide and large. The

total length of the bone is 0.157^{m}. The width of the lower end is 0.102^{m}.

The femur.—The femur is of a very simple type. There is no distinct head, and there is the usual concavity on the anterior face near the proximal end. There is a low but distinct ridge connecting the upper and lower ends on the anterior (inferior) face which crosses the bone somewhat obliquely. The distal condyles are almost entirely on the anterior face. The length of the bone is 0.150^{m}.

Only the proximal ends of the bones of the forelegs remain, but these, with the described bones of specimen No. 62, show that they were proportionately short and stout. In the description of specimen No. 62 figures were given showing that the phalanges were short, and that the foot must have been short and strong, with stout nails or claws, perhaps fitted for digging. Unfortunately, no attempt can be made to give the phalangeal formula.

Form and habits.—Cope makes the following suggestions regarding the *Diadectidae:*

> There is some reason to believe that the Diadectes relied exclusively upon the pineal eye for the sense of sight. The species of the family were subterranean in their habits, since their humeri indicate great fossorial powers, resembling those of the existing monotremes and even the moles. The vertebræ are locked together with hyposphen beside the usual articulations, and the arches of the neural canal form an uninterrupted roof from the skull to the tail, of extraordinary thickness and strength. That the species are not aquatic is rendered probable by the fact that the orbits do not look upward. Their superior borders are, on the contrary, prominent and straight. Add to this fact the apparent absence of optic foramina, and the probability that the *Diadectidae* were blind and subterranean in their habits becomes still stronger.

There seems little doubt that the points made by Cope are in the main correct. The animals were undoubtedly flat of body and strong of limb in regard to their digging powers. It may be doubted, however, if there is sufficient evidence to warrant the suggestion that they were blind. If they resembled the turtles as much as seems probable, it is very possible that the optic nerves escaped from the brain case in the same way without any special foramen.

It will be seen from the above description that the family *Diadectidae* must be removed from the *Cotylosauria* and placed in the order *Chelydosauria.* It also supports in a most striking manner the

statement made by Cope that the last order was ancestral to the turtles. It is not assumed that the *Diadectidae* are the direct ancestors of the turtles, nor can this statement be made in regard to any of the *Chelydosauria;* for in none is there any beginning of the development of a plastron, and only an incipient carapace, which cannot be regarded as determinative, as it also occurs in an amphibian *Dissorophus*, of the same beds. The only features of the body skeleton prophetic of the turtles are the beginning of the carapace and the number of presacral vertebræ, which is eighteen—a number which also occurs in many of the *Cotylosauria.* It is in the skull that the testudinate affinities appear. For convenience of discussion, the seven most important points are listed below:

1. The form and relations of the quadrate.
2. The degenerate palate and the disappearing transverse bone.
3. The absence of teeth on the pterygoids and palatines.
4. The absence of a parasphenoid process on the basisphenoid bone.
5. The absence of prevomers and the presence of an anteriorly placed single vomer (parasphenoid).
6. The method of entrance of the internal carotid arteries into the skull.
7. The presence of paired descending plates from the skull roof anterior to the brain cavity.

These will be discussed in order.

1. The form and relations of the quadrate. In the order *Cotylosauria* there are, as in the *Stegocephalia*, but five openings in the skull roof—the nostrils, the orbits, and the pineal foramen. The quadrate region is covered by dermal bones, so that the quadrate bone is seen only from behind or below to any extent. In the *Chelydosauria*, as described above, the quadrate appears on the side of the skull, and forms a portion of the side wall, surrounding an opening, the meatus auditus externus; the meati of the two sides forming a third pair of openings to the interior of the skull. As pointed out in the description, the quadrate bears exactly the relations to the bones of the roof and lower portion of the skull that the same bone bears in the turtles, and there is a suggestion of an overhanging hook on the posterior edge, indicating the beginning

of a closure of the bone to form a complete tympanic ring. But we know that there are many turtles in which the tympanic is open behind. Baur gives the following list: *Amphichelydia*, *Dermatemydidae*, *Staurotypidae*, *Kinosternidae*, *Toxochelydae*, *Platysternidae*, *Emydidae*, and *Adelochelys*.

2. The degenerate palate and the disappearing transverse. It is evident that the palate is very different from that of the *Cotylosauria* and from any of the more primitive orders of reptiles, as *Proterosauria*, *Proganosauria*, *Rhyncocephalia*, etc. There is no anterior rostrum (presphenoid auct.) on the basisphenoid; there are no paired prevomers; the palatines and transverse are degenerate; there is no descending buttress on the external process of the pterygoids for the lower jaw. The condition of the anterior rostrum of the basisphenoid and the prevomers is discussed below. It is apparent that the palate is in process of change toward a new type. It may well be that the *Diadectidae* show an extremely degenerate example of this change, and that the more successful line showed no such violent differences from the parent form at any stage. The ridge-like form of the palatines on the edge of the maxillaries speak of their extension toward the middle line to meet a median element extending far posteriorly—an element which already exists, but from which they are separated by the long antero-posterior vacuities of the palate. The firm attachment of the pterygoids to the maxillaries is indicative of the final disappearance of the transverse, one of the most characteristic features of the Chelonian palate.

3. The absence of teeth on the pterygoids and palatines. In all other forms of the *Cotylosauria* there are teeth on the pterygoids or palatines, or both. Two specimens show that they are absent in the *Diadectidae*.

4. The absence of a parasphenoid process on the basisphenoid bone. If we accept without argument or review the position taken by Broom, that the true vomer is the parasphenoid in a new position and with a new function, and that the paired elements of the reptilian skull usually called vomers, are really distinct elements, then the identification of the parasphenoid in the skull becomes of extreme morphological importance. It has been shown by Howse and Swinnerton (Howse and Swinnerton, 1901) and Siebenrock (Sieben-

rock, 1897) that in *Sphenodon* the rostrum of the basisphenoid is the parasphenoid; the basisphenoid with its anterior rostrum develops from three centers—two posterior, in the cartilage of the skull axis, and one anterior, in the lining membrane of the floor of the pituitary space. The same observation has been reported and confirmed in the development of the Lacertilian skull. It is evident, then, that the rostrum of the basisphenoid is the remnant of the parasphenoid in the reptiles. (It is common to refer to this rostrum as the presphenoid—a distinct error, as the presphenoid is a continuation of the cartilaginous basicranial axis, and not a membrane bone.)

There is no such rostrum developed in the turtles. I am aware that Parker reported (Parker and Bettany, 1877, p. 214) that the basisphenoid of the turtle is developed from three centers, as in the *Lacertilia*, but this is denied by Siebenrock (Siebenrock, 1897), who also cites Rathke (Rathke, 1848), as follows:

> Dass sich das Basisphenoideum bei den Schildkröten nur in einfacher Zahl bildet denn selbst bei denn reifern Embryonen, konnte Rathke nicht das geringste Zeichen anfinden, dass es ursprünglich aus einem hinteren und vordern Stücke bestanden hatte.

Siebenrock further explains the apparent rostrum of the turtles by the elongation and approximation of the trabeculae inferiores (Siebenrock, 1897, p. 18).

In an examination of the *Reptilia* I find the following condition: The parasphenoid is absent as a rostrum of the basisphenoid in the *Chelydosauria*, *Testudinata*, *Cotylosauria partim* (*Telerpeton*, *Pareiasaurius* (?), *Procolophon*). It is present in the *Ichthyopterygia*, *Sauropterygia*, *Squamata*, *Theropodous Dinosaurs* (*Diplodocus*), *Cotylosauria partim* (*Pariotichidae*, *Labidosaurus*).

It now becomes necessary to discuss this point in connection with the fifth point:

5. The absence of the prevomers and the presence of an anteriorly placed single vomer. In the forms where there is a rostrum on the basisphenoid there are always paired prevomers, but where this rostrum is not developed there is a single, anteriorly placed vomer and no prevomers.

Broom has shown (Broom, 1904) that the median vomer of the turtles is probably the parasphenoid. The condition of the vomer of

the *Diadectidae* indicates that it may well be the parasphenoid detached from the basisphenoid and placed in an interior position, retaining its connection with the basisphenoid by extension of the cartilaginous basicranial axis, if at all. Perhaps the median ossified plate described as descending from the anterior part of the skull roof is an ossification of the ethmoid complex, and aids in the support of the vomer. The list given above shows that the parasphenoid rostrum of the basisphenoid is not a constant feature even in well-defined *Cotylosaurians*.

6. The method of entrance of the internal carotid arteries into the brain cavity. In the *Rhynchocephalia* and *Squamata* the carotid arteries divide beneath the skull floor, and the internal carotids pass through the basisphenoid from below, leaving a pair of foramina which are very constant and noticeable features. In many of the turtles the carotids pass into the skull through a foramen posterior to the quadrate, and then divide into an internal and external carotid. The internal carotids enter the basisphenoid through the side of the bone, and then pass out of the top, leaving no foramina on the lower surface. This character is not constant for all turtles. In some the internal carotids enter the pterygoid, or the foramen is in the suture between the basisphenoid and pterygoid.

I find foramina on the lower surface of the basisphenoid in the *Rhynchocephalia*, *Squamata*, and probably *Dinosauria*. In the *Testudinata* (*partim*), *Chelydosauria*, *Crocodilia*, there are no foramina on the lower side of the basisphenoid.

7. The presence of paired descending plates from the skull roof anterior to the brain cavity. As no trace of an epi-pterygoid was found, the paired plates descending from the lower surface of the parietals is strongly prophetic of the plates in the turtles. They have the same position and, apparently, the same relation to the pterygoids below and the foramen for the fifth nerve.

Opposed to the Testudinate affinities is the absence of any plastral elements, even abdominal ribs, and proscapular process of the shoulder girdle.

In just the characters in which the *Chelydosauria* (*Otocoelidae*, *Diadectidae*) approach the turtles they are distinct from the *Cotylosauria* (*Pareiasauridae* and *Pariotichidae*), and so it seems very probable that we have in the *Diadectidae* forms very closely related

to the ancestral stem of the turtles which tell us much regarding the development of the *Testudinata* directly from the *Cotylosauria*.

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